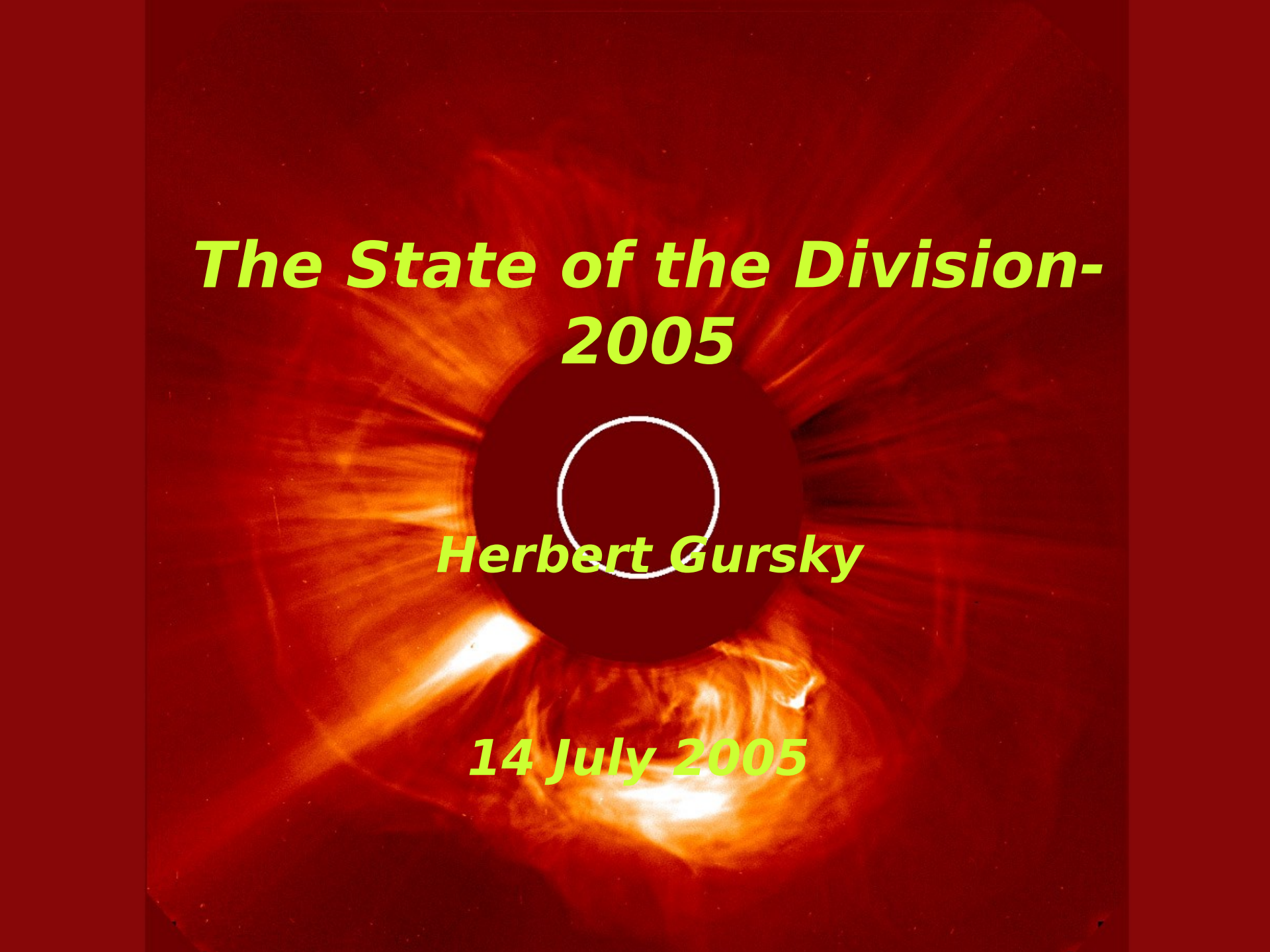


The State of the Division-2005

Herbert Gursky

14 July 2005

DIVISION AND LABORATORY FINANCES

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Funding	42.5	55.1	55.4	49.9	39.4M$
Fed	80	79	82.7	82.6	82.9 fte
Contractors	46	57	61	66.5	63.2 fte
Overhead	22.98	24.89	23.91	21.81	22.06$/hr
Lab Funding	841	887	940	979	934M$ (est)
Fed	2573	2560	2564	2473	2455 fte
G&A	18.24	20.05	22.18	22.00	23.68$/hr

Division Research Projects

Capture of atmospheric and near-earth dust. Development of BEST, SSGM for Missile Defense. Analysis of UV remote sensing data from USA, SSULI, GUVI. Transition of GAIM to operational units. Development of ANDE calibration spheres for satellite tracking. Development of small UV photometer for Taiwan space project. Inversion of infrasound data to yield atmospheric data. Extension of weather models to high altitude. Study of the atmospheric neutral density at high altitudes. Study of energetic particles and gamma rays from the sun. Study of energetic gamma rays from astronomical sources. Study of the timimg characteristics of cosmic x-ray sources. Development of models of astronomical sources of energetic radiation. Development of high performance computers for space applications. Development of the calorimeter for GLAST. Development of Compton gamma ray imaging device based on silicon devices. Development of ultra-low background radiation detection facility. Study of variable cosmic x-ray sources. Study of navigation and timing using periodic pulsing x-ray sources. Development of high performance computing for space application. Development of solar coronagraphs and imagers for the STEREO mission. Development of new, high resolution instrument to study the sun from sounding rockets, Use of SUSIM data to study the solar radiance. Study of CMEs and other phenomena seen in the LASCO and EIT data. Utilize multilayer technology to develop optics for UV and X-ray applications. Application of high-speed, flash x-ray generator/imager. Development of x-ray diagnostic instrument for National Ignition Facility….

Over 100 research projects engaged in by the Division's scientists, post-docs and their numerous collaborators

STATUS OF SPACE EXPERIMENTS

Operating

SUSIM-UARS UV Solar Radiance

LASCO-EIT coronagraph, EUV imager

SSULI UV spectrometer

In Development

GLAST energetic gamma ray survey

SECCHI coronagraphs and imager

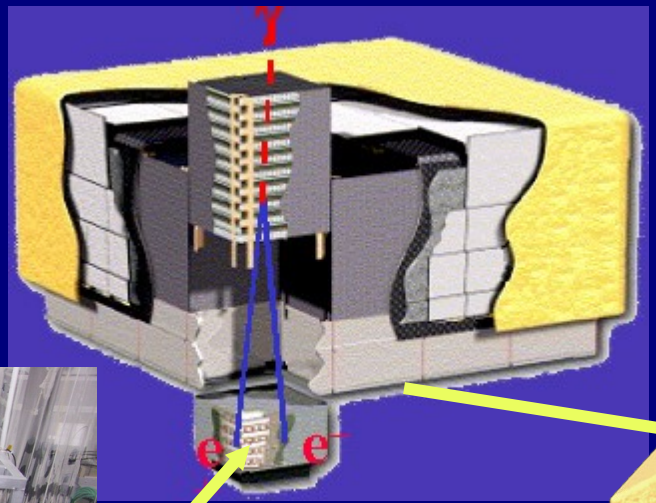
EIS high resolution spectrometer

SHIMMER (STP-SAT) Michelson interferometer

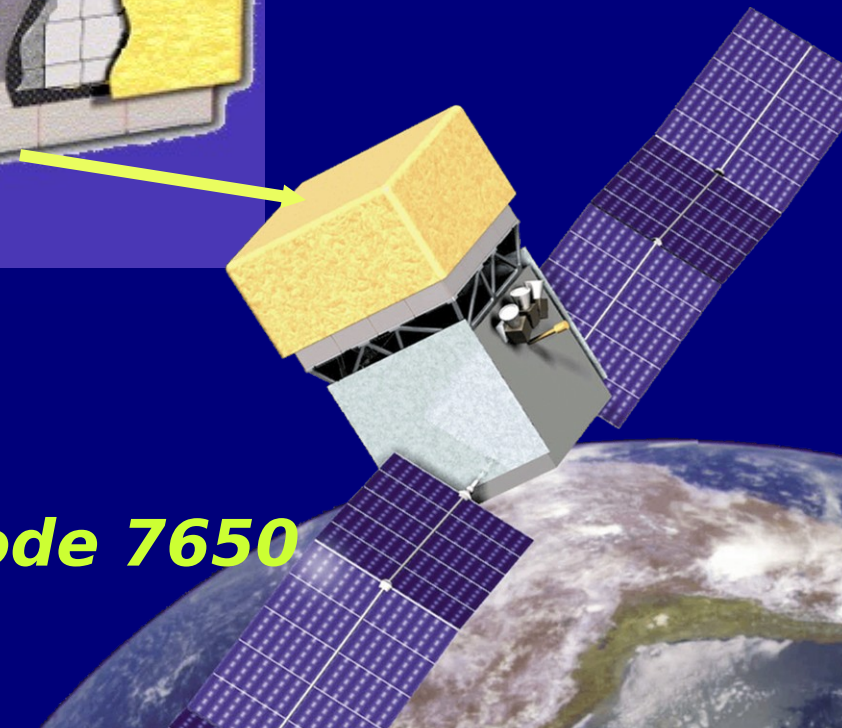
COSMIC ultraviolet photometer

18 Calorimeter Modules Delivered for GLAST

GLAST, a major NASA initiative, measures the direction, energy and arrival time of cosmic gamma rays in the range 20 Mev and 300 Gev.

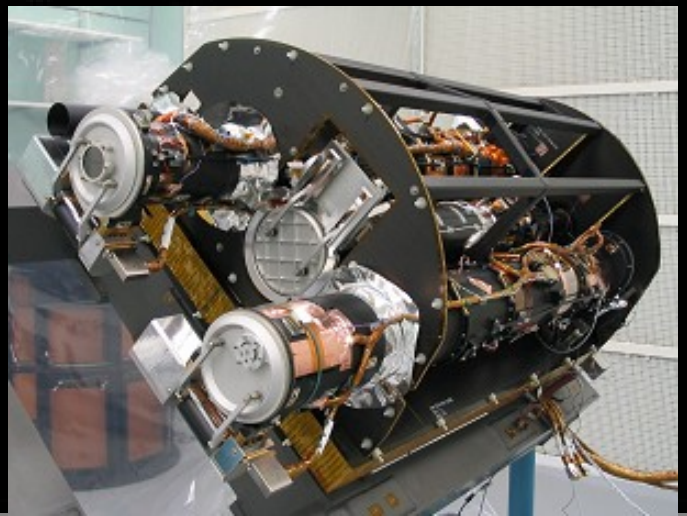


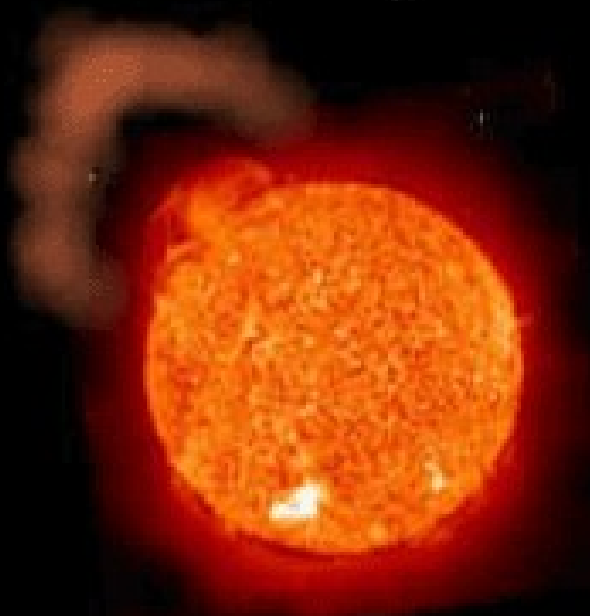
From Code 7650



SECCHI Instruments Delivered for STEREO

Instruments include 3 different coronographs and an EUV imager on two independent space-craft that will view the Sun from two vantage points.

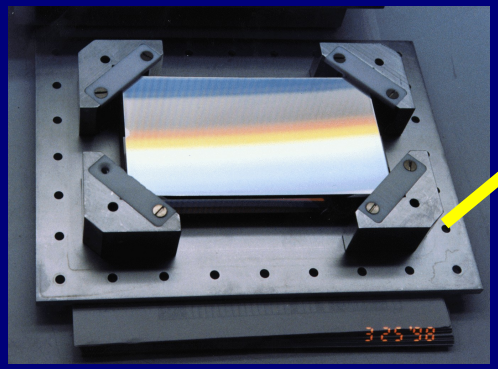


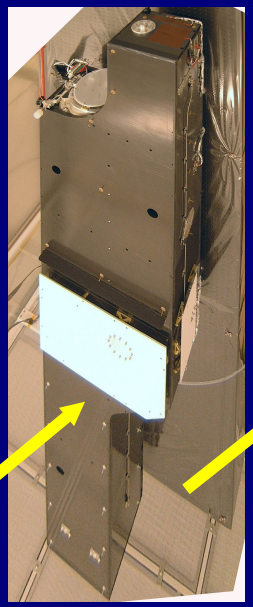


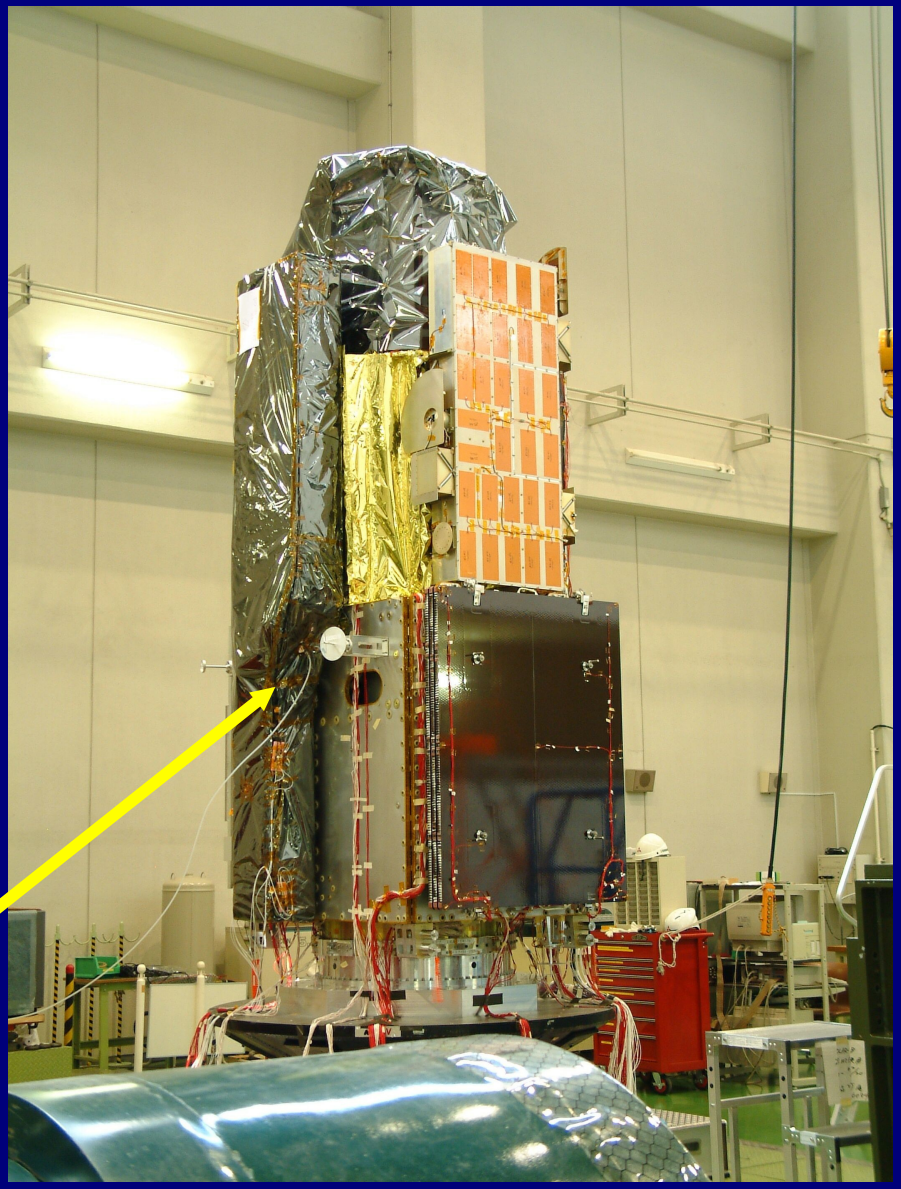
From Code 7660

EIS HARDWARE DELIVERED

A high resolution spectrometer to study the sun. To be flown as part of the Japanese Solar-B mission







From Code 767

The Emergence of the EIS Instrument

High Resolution Spectroscopy from space had its origin with Richard Tousey's investigations of the Sun with V2 rockets in the 1940s and with Tousey's and Herbert Friedman's satellite experiments of the 60's.

More Recent History

The 70s
The 90s

George Doschek and Uri Feldman develop Bragg Spectrometer for P78-1

Dewitt Purcell develops spectrometers for SkyLab Instruments

The 80s

George Doschek and Uri Feldman develop Bragg Spectrometer for Japanese Solar-A mission

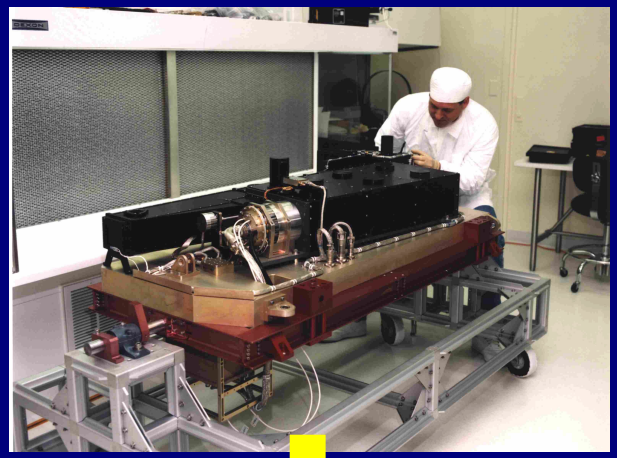
Gunther Brueckner develops the HRTS spectrometer

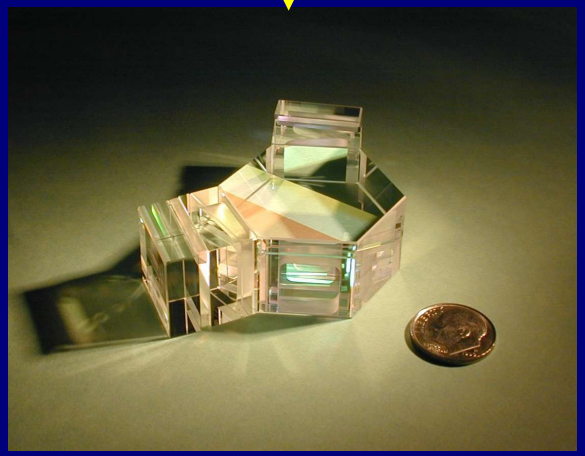
John Seely develops multilayer technology

Charlie Brown and Clarence Korendyke develop high quality instruments for solar and other studies.

Mike Kowalski develops high resolution gratings for JPEX

MAHRSI/SHIMMER





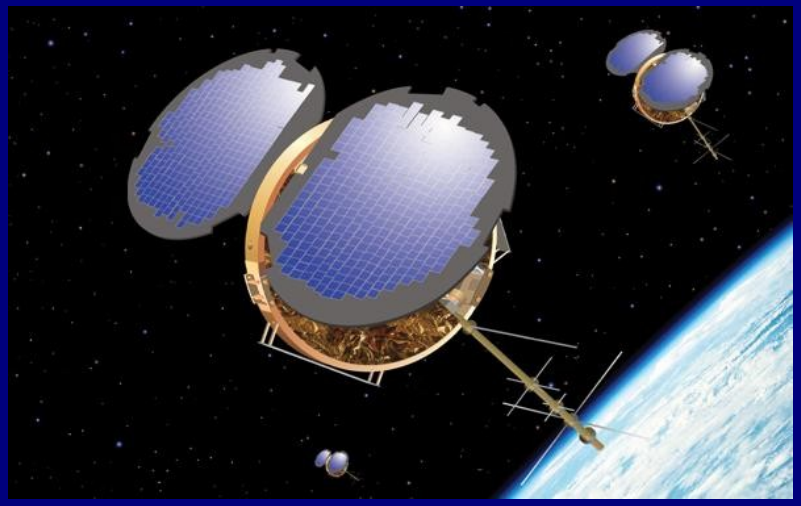
From Code 7640

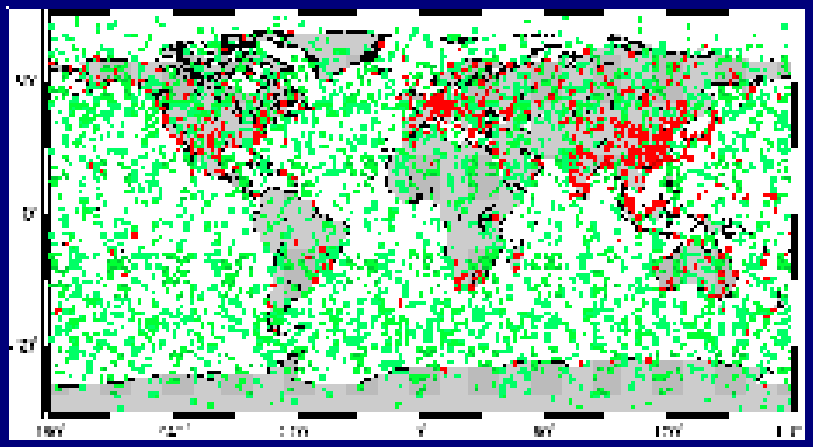
MAHRSI was a traditional grating spectrometer that flew from the German SPAS carrier from the shuttle and obtained the first measurements of OH.

SHIMMER (SHS), a Michaelson Interferometer, developed with the Universities of Wisconsin and St. Cloud, has flown on the shuttle and had been manifested on the NASA AIM satellite. It is scheduled to fly on an STP sponsored mission.

Three new SHS in development: to measure atomic nitrogen in the troposphere, chem-bio agents in the troposphere and fires on ships

COSMIC





- **Constellation Observing System for Meteorology, Ionosphere, and Climate**
  - **Joint US/Taiwan project**
  - **Collaboration of NSF, NASA, USAF,NOAA,ONR (& NRL), NSPO (Taiwan)**
  - **6 satellites performing 2500 GPS occultations, radio beacon tomography, and UV photometry**
  - **6 planes at different local times**

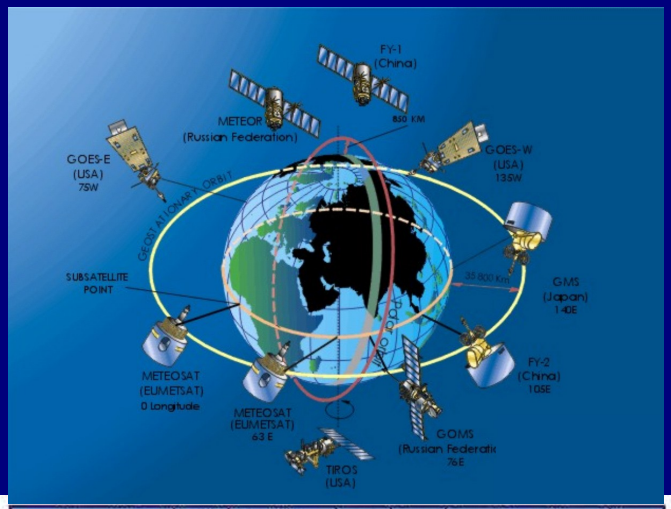
From Code 7607

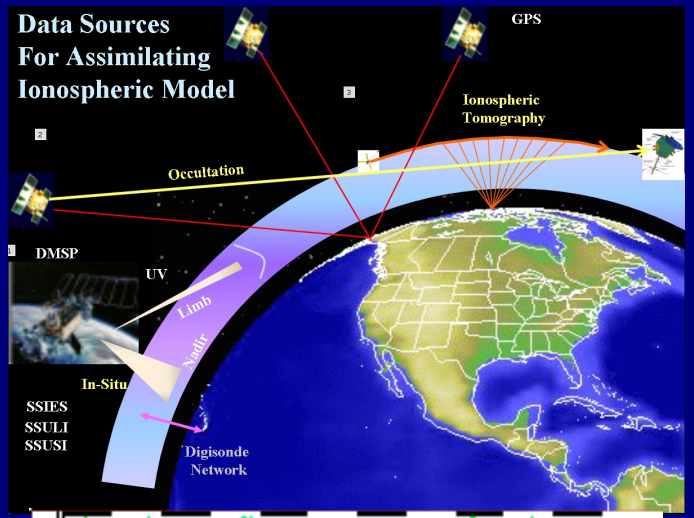
DIVISION RESEARCH MODELS

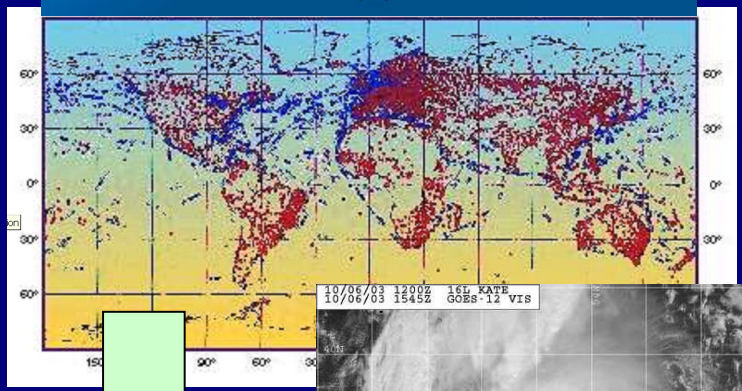
MUCH OF THE DIVISION'S RESEARCH CAN BE DESCRIBED IN TERMS OF PHYSICAL MODELS OF BROAD UTILITY

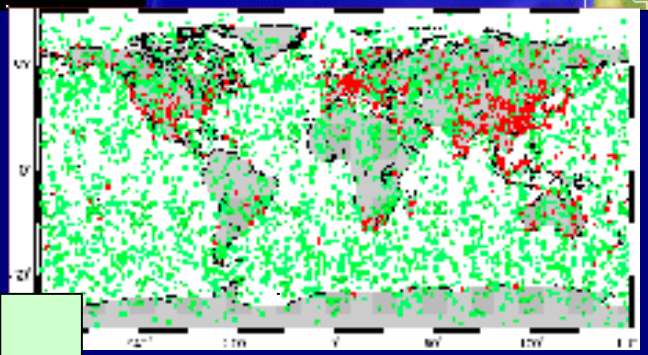
COSMOS	**FASTAR hydrodynamic model of accretion flows onto white dwarfs**
	CRÈME describes the heavy elements in the cosmic rays and their effect on electronics
	CHIANTI an atomic physics model of astrophysical plasmas, including the Sun's.
THE SUN	**CORONAL IMAGE DATABASE is used to predict the onset of geomagnetic storms.**
	ARMS: A first-principles 3D MHD model for simulating explosive solar activity.
BETWEEN THE PLANETS	**NRL EUV MODEL models the solar EUV spectral irradiance**
	NRL 1D FLUX TUBE MODEL models coronal loops
IONOSPHERE	**WANG-SHEELY calculates the solar wind speed starting with the solar magnetic field and is used to predict geomagnetic activity**
MESOSPHERE	**GAIM a first principles model of the ionosphere.**
	NRL-MSIS models the neutral density.
	G2S models the wind from the ground-to-space
TROPOSPHERE	**MOUNTAIN WAVE FORECAST is routinely being used to forecast high altitude turbulence**
	CHEM2D a research model of the middle atmosphere.
EARTH	**NOGAPS-ALPHA high altitude version of the Navy's weather model**

GAIM, a New Ionospheric Weather Specification Paradigm

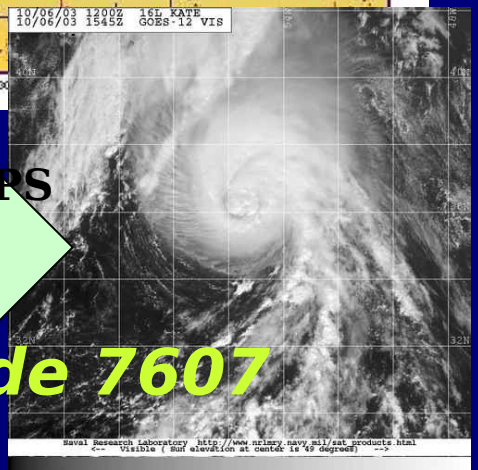




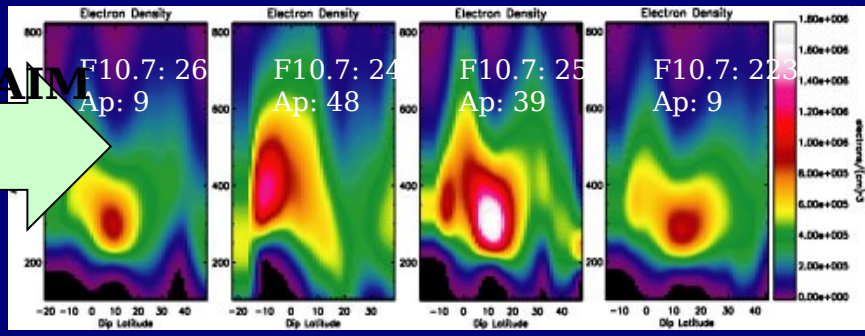




NOGAPS



GAIM

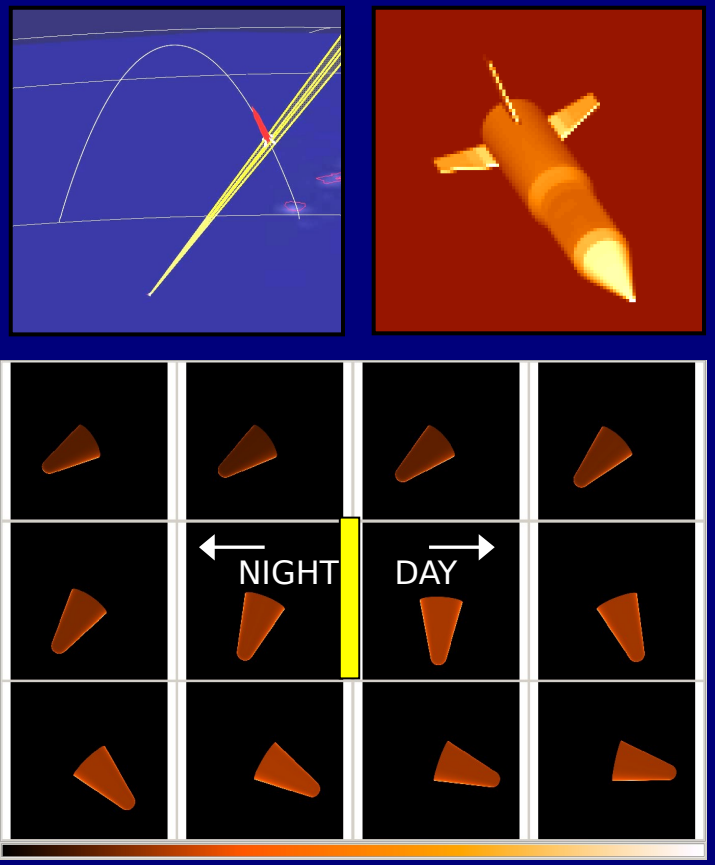


From Code 7607

Battlespace Environment & Signatures Toolkit (Replaces SSGM)

MDA's new physics-based modeling and simulation program

- Intended to simulate all major components of missile defense battlespace
  - Natural backgrounds (Earth, atmosphere, space, etc.)
  - Hardbody targets
  - Missile plumes
  - Countermeasures
  - Nuclear blasts
- Will cover all phases of flight: Boost, Ascent/Mid-course, Re-entry
- Phenomenologies to be phased in with each release

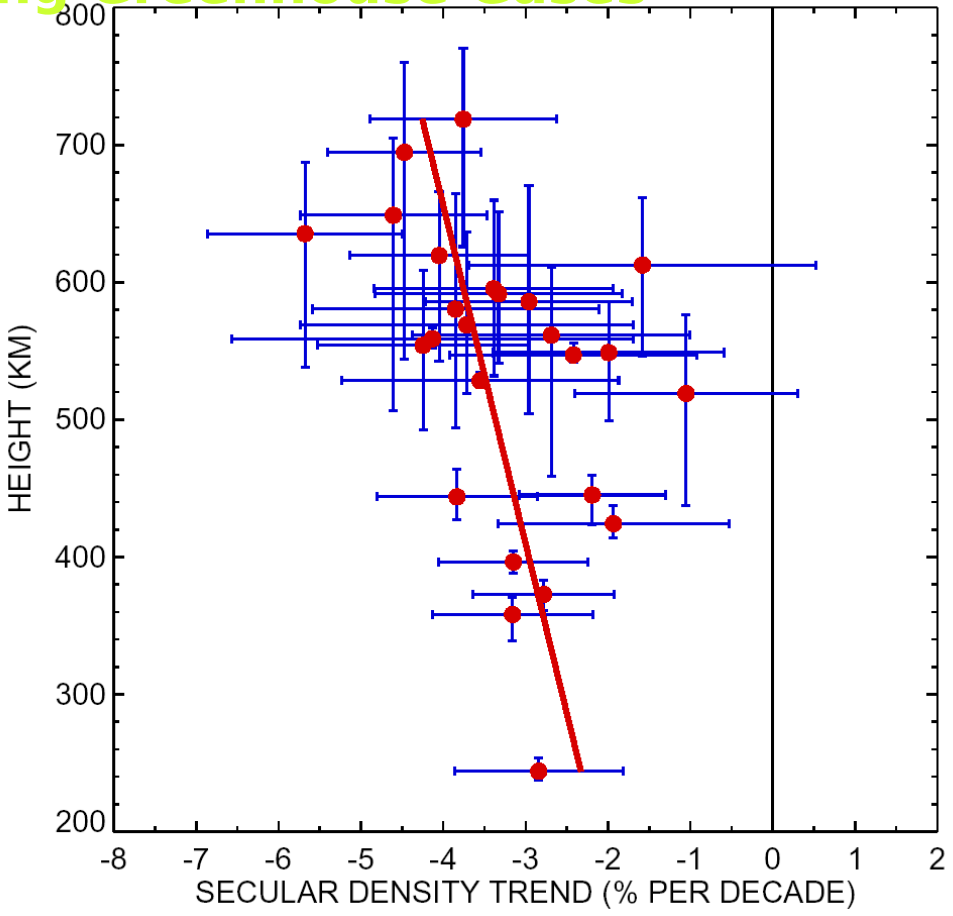


Will be *the* Verified, Validated, and Trusted capability to produce signatures of MDA's common engineering threats

From Code 7640

NRL-MSIS Yields Major Finding Relating to Global Warming

- New Analysis of the Orbits of 25 Long-Lived Satellites
- Steady Density Decline and Thermospheric Cooling
- Consistent With Increasing Greenhouse Gases



From Code 7640

High Altitude Turbulance Forecasting

(Steve Eckermann: Mountain Wave Forecast Model)

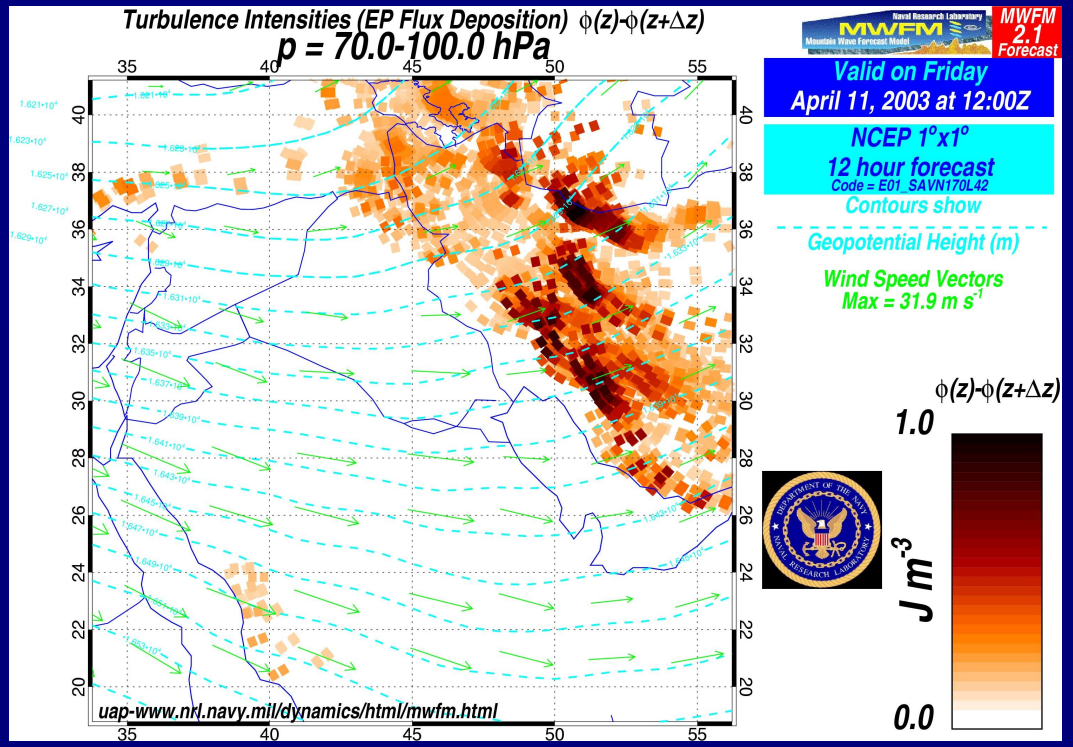
- Mapping of turbulence at high altitudes for U2 and Global Hawk mission planning

- **Capability Gap**
  - Ability to forecast high altitude turbulence in mountainous environment

- **Solution Provided**
  - +12 hour forecasts of mountain wave turbulence provided

- **Technology Status**
  - Utilized for predictions for OEF

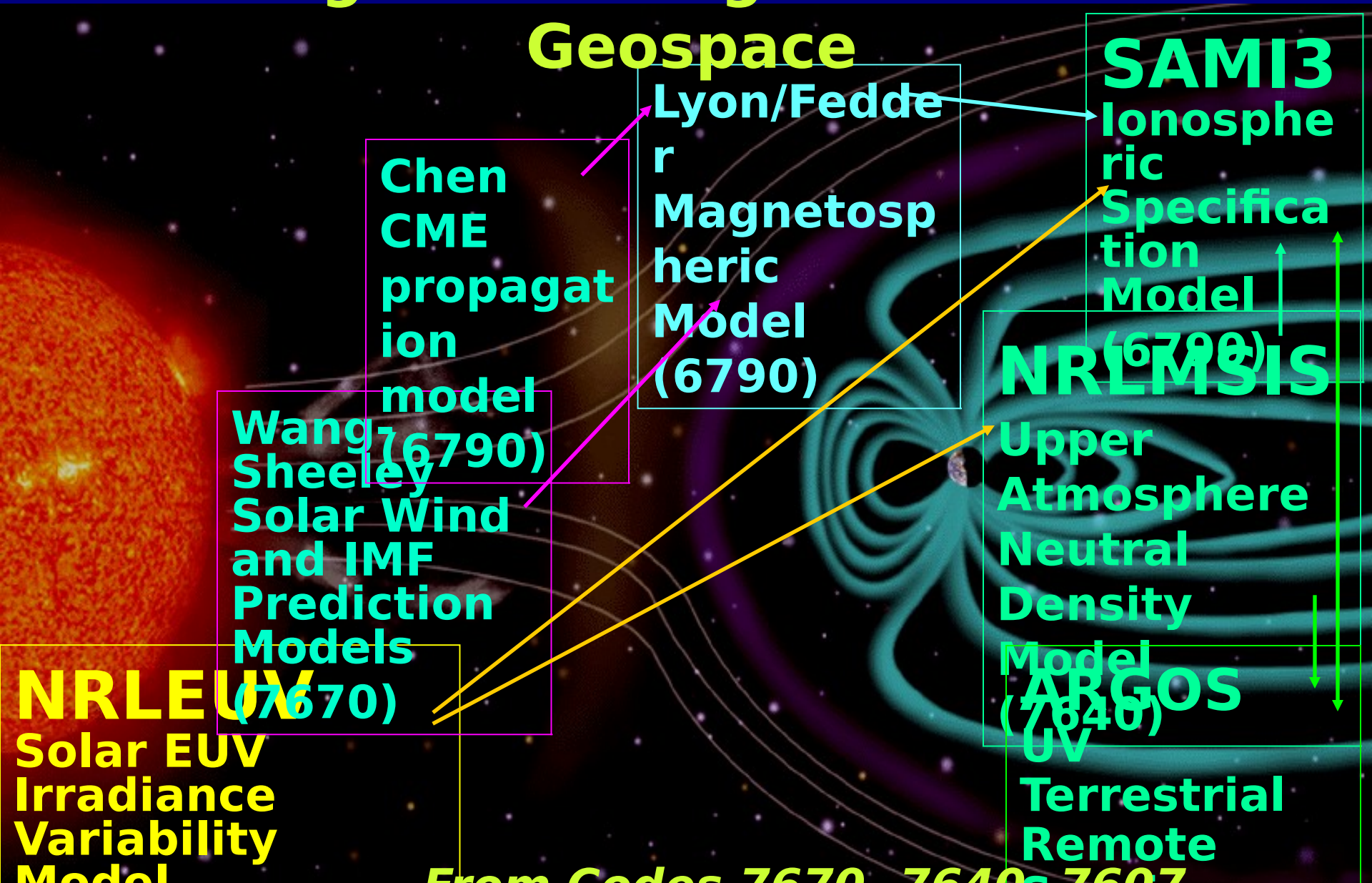
- **Operational Customer**
  - 9th Reconnaissance Wing, Beale Air Force Base



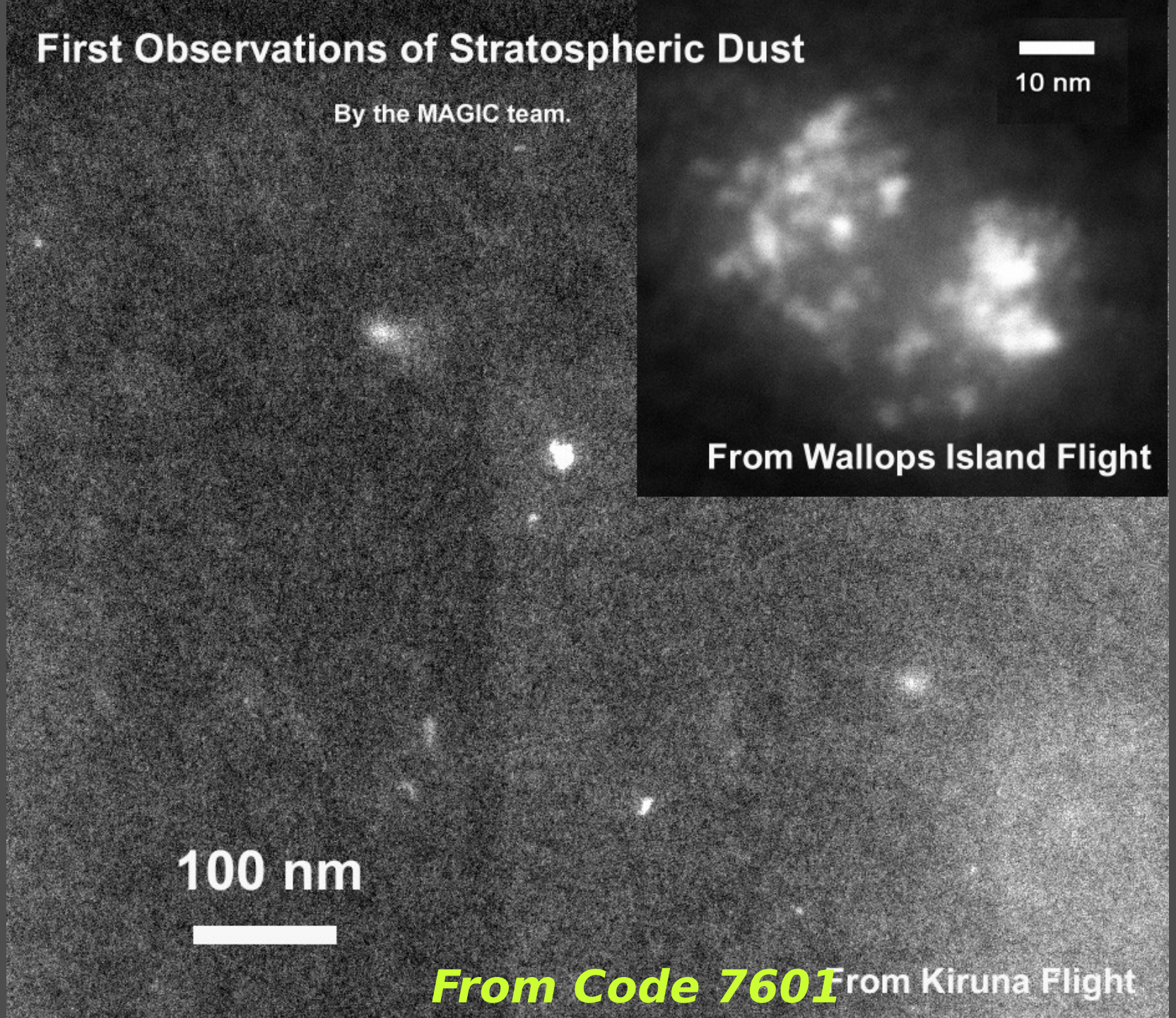
From Code 7640

(From Laboratory Command Brief)

The SHIP Research Initiative Moving to an Integrated Model of Geospace

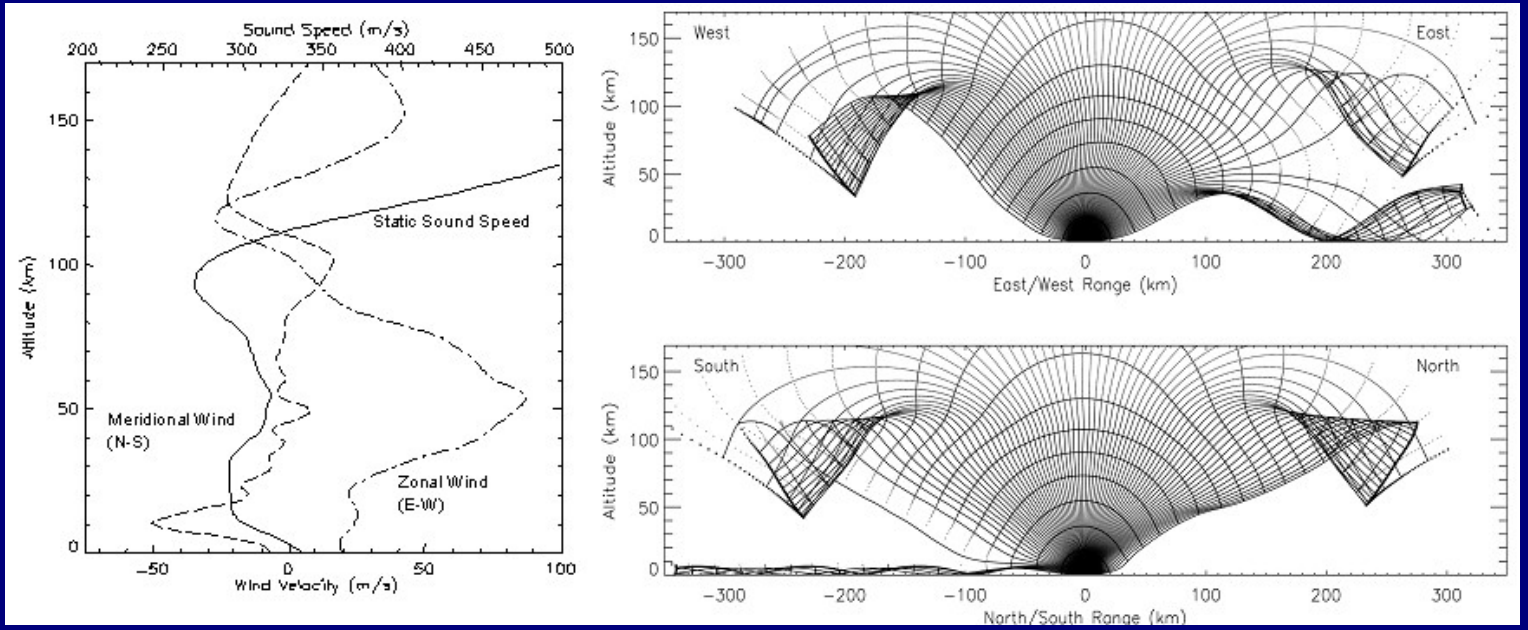


Highlights of the Research Program


First Observations of Stratospheric Dust
By the MAGIC team.
10 nm
From Wallops Island Flight
100 nm
From Code 7601
From Kiruna Flight

Infrasound Propagation

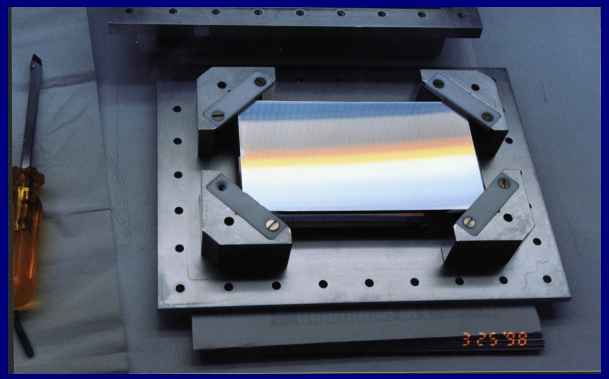
NRL scientists have used infrasound from known sources to determine atmospheric conditions.

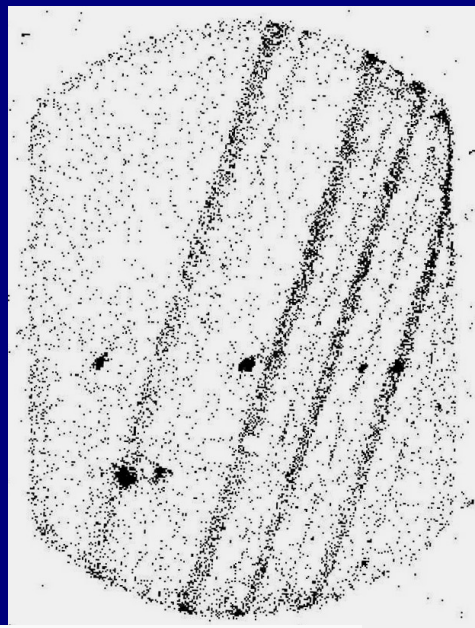


Infrasound is the atmospheric analog of seismic waves. They are acoustic waves that can for propagate for 100s of kilometers

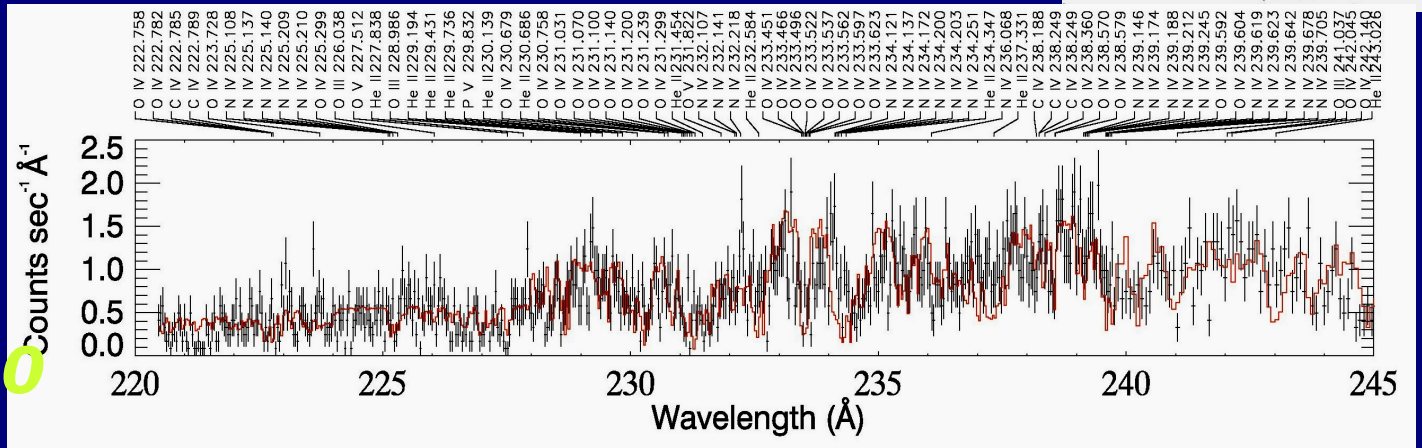
- **Many natural- and man-made sources. National interest is in the detection of nuclear explosions.**
- **NRL has been providing the background wind conditions (highly variable).**
- ***From Code***

JPEX rocket obtains first high resolution spectrum in the EUV spectral range of a White Dwarf



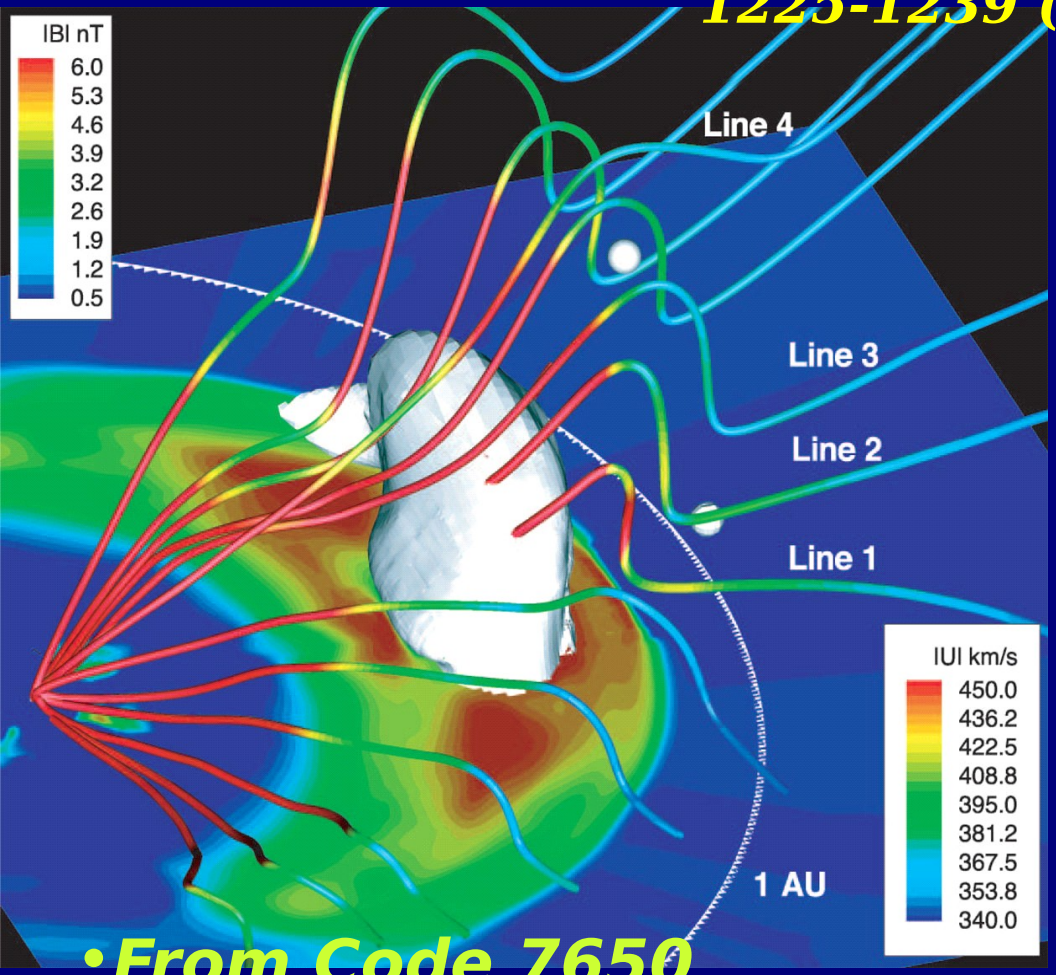


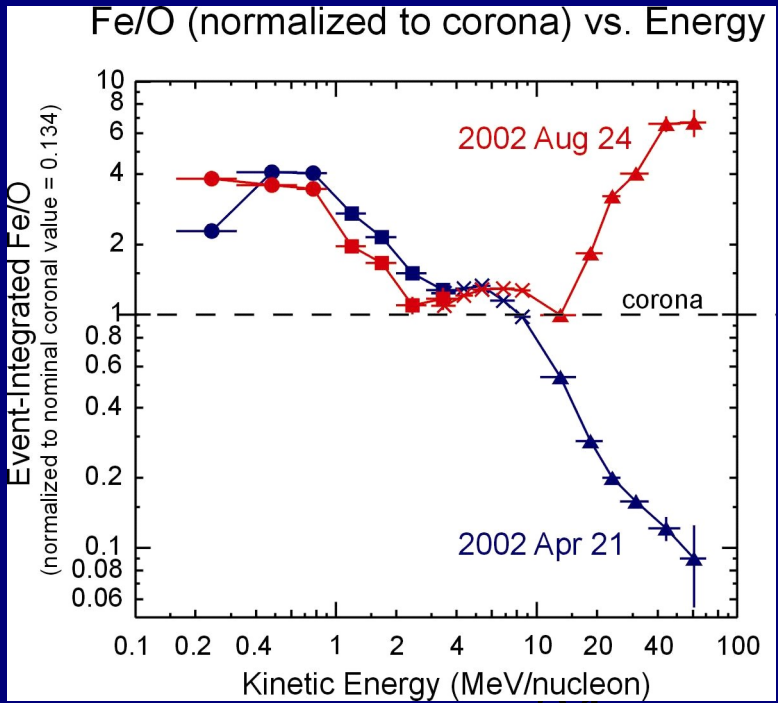
- *From*
- *Code 7650*



Evolution in Shock Geometry as the CME moves out from the Sun

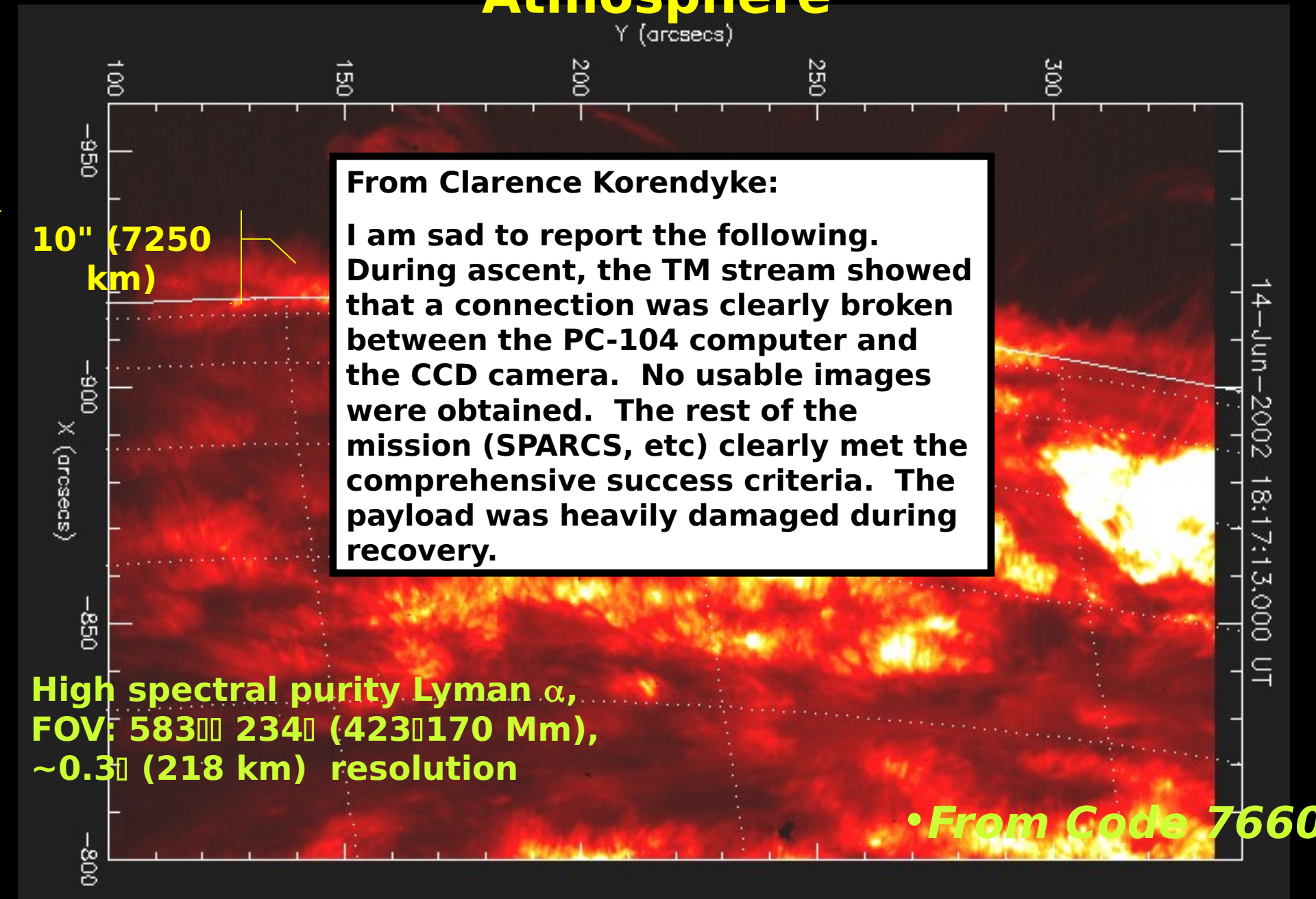
MHD Simulation from Manchester et al., ApJ 622, 1225-1239 (2005)





- From Code 7650

VAULT: Height of the Lyman α Atmosphere



From Clarence Korendyke:

I am sad to report the following. During ascent, the TM stream showed that a connection was clearly broken between the PC-104 computer and the CCD camera. No usable images were obtained. The rest of the mission (SPARCS, etc) clearly met the comprehensive success criteria. The payload was heavily damaged during recovery.

10" (7250 km)

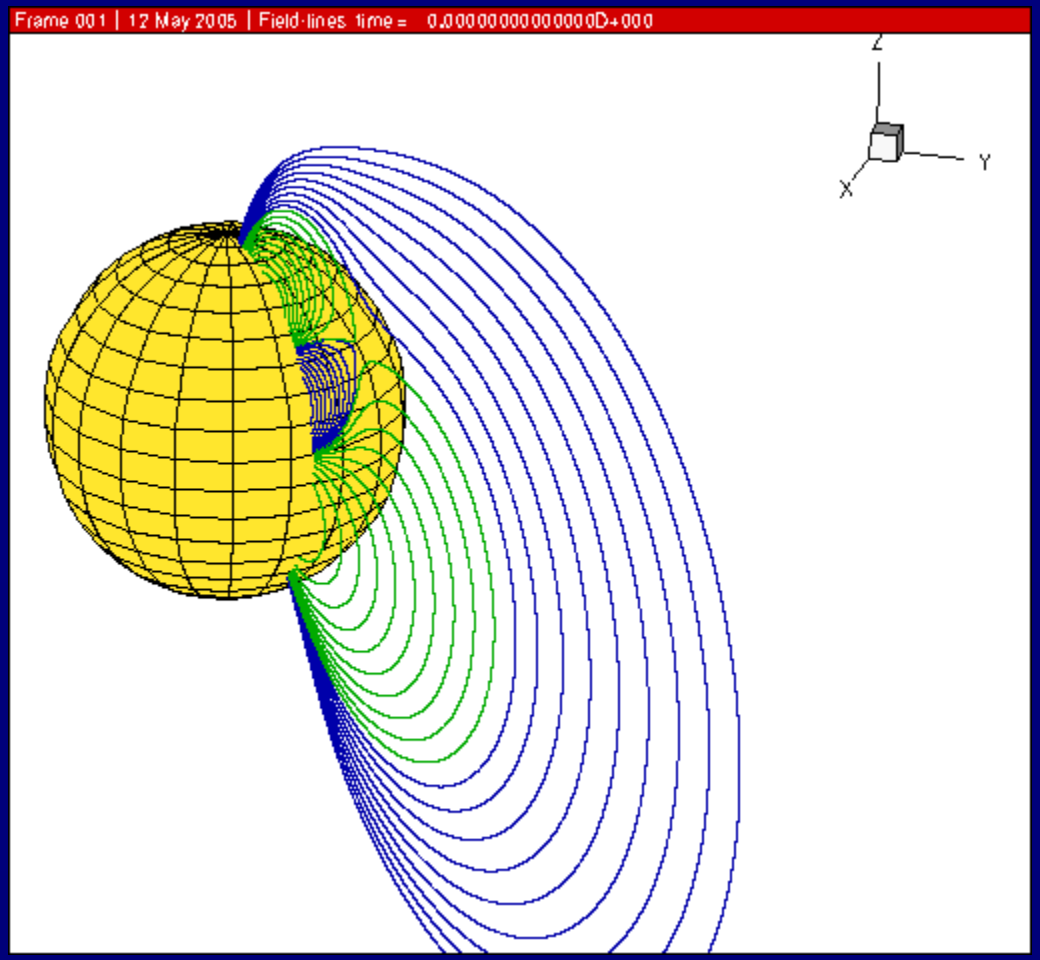
High spectral purity Lyman α, FOV: 583″ 234″ (423 170 Mm), ~0.3″ (218 km) resolution

• From Code 7660

NRL Breakout Model for CMEs

Magnetic Reconnection Driven by Field Line Shear

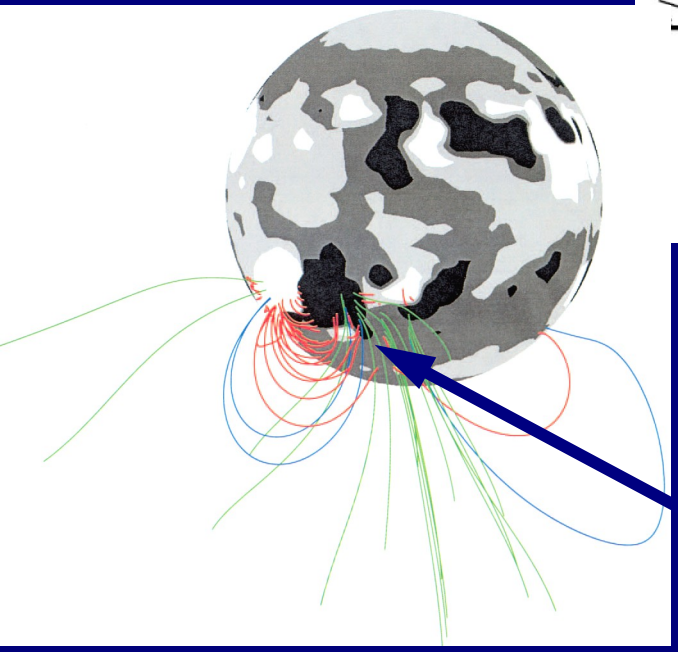
- Magnetic reconnection removes overlying field, destroying force balance and producing explosive expansion
- Model produces fast eruption with interplanetary shock
- Model now being used extensively by outside community to interpret observations, including both CMEs, solar flares and prominence eruptions.

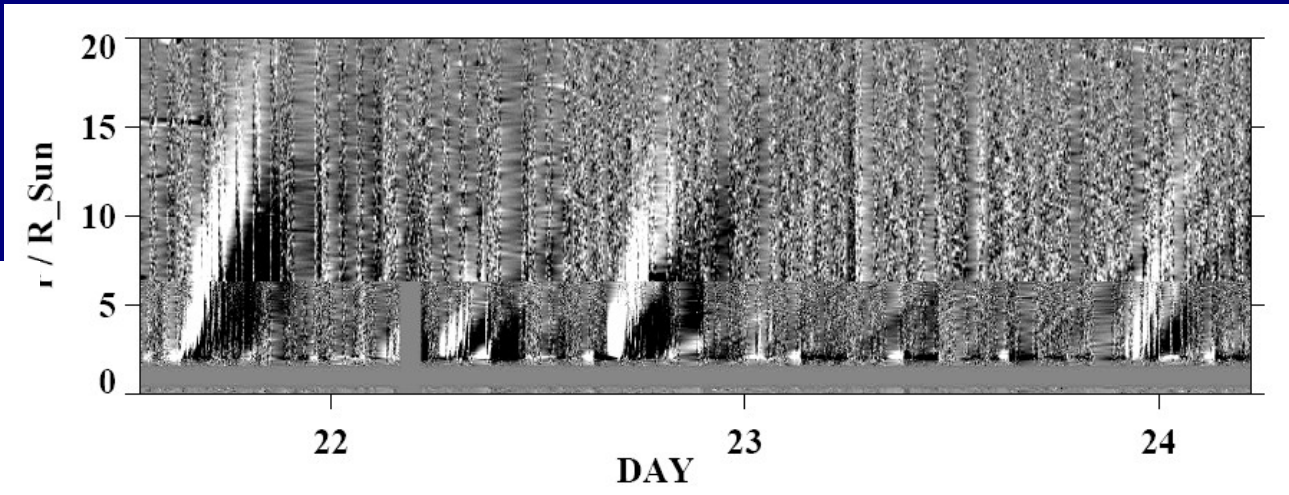


- From Code 7670

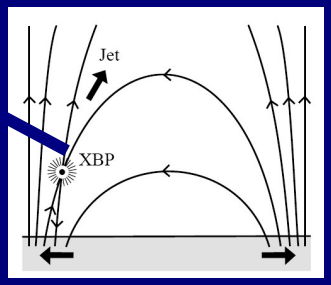
Solar Jets—A Major Feature of the Sun

Jets emerge from regions of emerging magnetic flux in or adjacent to coronal holes. They are accompanied by intense beams of energetic particles





Recurrent jets from region of emerging flux



Region of recombination

Wang-Sheeley reconstruction of magnetic

- ***From Code 767***

What the Division's Solar Groups have Done

Based on:

LASCO imagery

The work of Neil Sheeley and Y-Ming Wang on the emergence of Sun's magnetic field

The work of Spiro Antiochus and his colleagues on modeling magnetic reconnection

And the work of many others

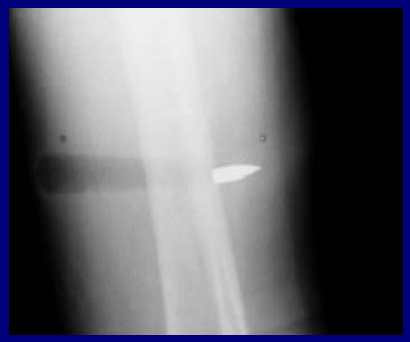
Accounted for Many of the Explosive Phenomena that Occur in the Solar Atmosphere

APPLIED DEVELOPMENTS

1. BEST--missile defense modeling and simulation tool
2. GAIM--an entirely new ionospheric model
3. Calibration spheres for satellite tracking facility
4. A version of SHIMMER to detect shipboard fires
5. Navigation in space by observing pulsing x-ray sources
6. Imaging gamma ray detectors for inspection purposes
7. National ultra-low background facility
8. High performance computing for use in space
9. Diagnostic x-ray spectrometers for the National Ignition Facility
10. Flash x-ray generator and imaging detector for inspection purposes

X-Ray Radiography of High-Velocity Bulle

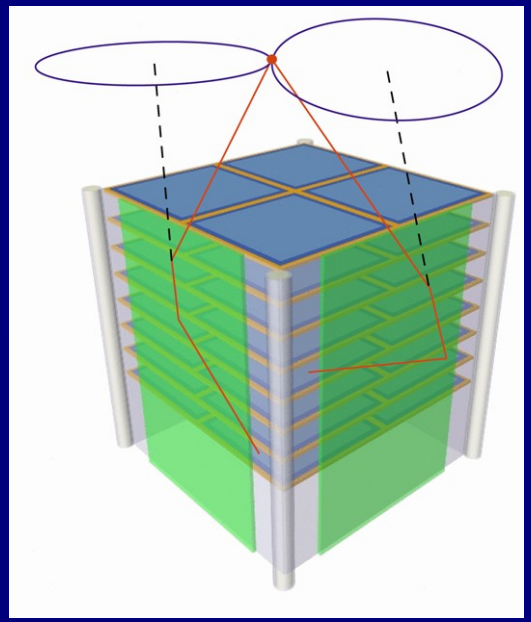
- Bullet interactions with cadavers were studied at the Armed Forces Institute of Pathology under approved AFIP and NRL human tissue protocols.
- First observation of cavitation caused by high-velocity bullets. This work invalidates previous studies using gelatin tissue surrogates.
- Applications to trauma reduction and body armor.

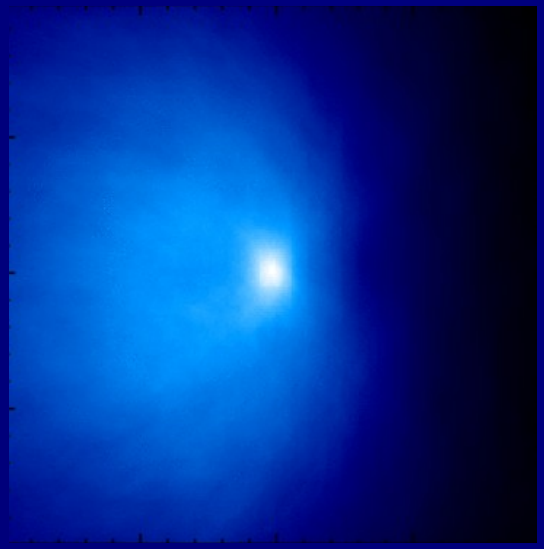


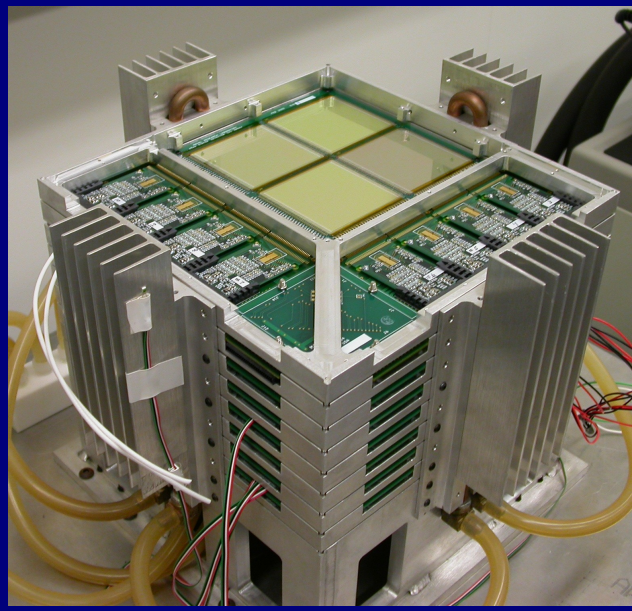

- *From Code 7670*

DTRA Prototype Compton imager Unit

Proof of concept instrument for the long-range detection of shielded nuclear materials(^{235}U).







- **8 layer prototype (1.6 cm total thickness of silicon)**
- **4 detector per layer (~140 cm^2 of frontal area)**
- **Strips are daisy-chained to minimize electronics**
- **128 strips per side: 0.9 mm-wide strips**

From Code 7650

PROSPECTS

The Division will be deluged with huge amounts of high quality scientific data from its upcoming space missions in the next few years.

Division's base 6.1 funding appears to be secure. Division has been competitive in obtaining 6.2 funds

The Division has delivered three major space instruments that assures a flow of high quality scientific data for at least a decade

A number of developments of space instruments are underway that should provide for entirely new instruments in the future

Division scientists have been responsible for several entirely new scientific initiatives that have achieved wide recognition

A number of applied activities are receiving support from DoD, DoE, DARPA, DTRA and other government agencies.

Where are the Flies in This Ointment?

The Division will be deluged with huge amounts of high quality scientific data from its upcoming space missions in the next few years but NASA has not been especially generous in funding post-launch operations and data analysis.

Significant changes in patterns of NASA funding caused by the new human exploration initiative have reduced the funding for major scientific missions so the Division may have to make do with significantly less funding in the future so it will have to shrink in order to keep overhead in bounds. However the Division does have a significant surplus from past overhead collection that will help alleviate the problem.

The DoD and the Navy have not yet achieved stability in its S&T requirements and funding based on the new warfare paradigms.

The Division's value to the Navy lies more with the

TWENTY YEARS OF ACCOMPLISHMENTS

1. *Development of UV remote sensing as a basis for ionospheric monitoring*
2. *Emergence of middle atmosphere research as a new area*
3. *Development of MAHRSI and SHIMMER as new technology for studying the middle and upper atmosphere*
4. *Use of multilayer technology to develop new instruments, especially high resolution diffraction gratings*
5. *Key contributions to GLAST*
6. *Use of silicon and germanium for novel detectors of x and gamma rays*
7. *Development of LASCO for the SOHO mission which has yielded qualitatively new data on the solar corona*
8. *Development of magnetic reconnection in the solar corona as a basis for the origin of coronal mass*

SUPPORT TO THE WARFIGHTER

Division research directly supports warfighter requirements in the area of Battlespace Environments. These include:

1. Characterization of the space environment including forecast of geomagnetic activity through the observation of coronal mass ejections and characterization of the heavy particle environment.
2. Modeling of important middle and upper atmosphere phenomena; in particular neutral density with NRL MSISE, turbulence with MWFM and transitioning GAIM to Air Force and other users.
3. Support advances in tropospheric weather with work on NOGAPS-ALPHA.
4. Develop new technology, including fault tolerant computing, large scale computers for space, gamma ray imaging, x-ray imaging and spectroscopy.

QUESTIONS?